Changes in vegetation structure and floristics under a powerline easement and implications for vegetation management

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Abstract

Utility corridors such as powerlines are widespread linear easements of highly modified vegetation which often fragment natural areas of conservation significance. Vegetation management along these easements is aimed at modifying vegetation structure by the removal of all tall shrubs and trees, which may have adverse impacts on flora and fauna diversity. Victoria's Bunyip State Park is bisected by a high voltage powerline easement which is managed by a four year slashing cycle. Repeated slashing has altered plant species composition and structure of the drier slope and ridge vegetation compared to unslashed adjacent Open Forest vegetation, but Wet Heath within the management zone has remained largely unmodified. At a broad level, plant species diversity in the easement is increased, and higher vegetation density has created small mammal habitat. The powerline easement did not appear to facilitate weed invasion. Vegetation management by repeated slashing has altered the vegetation, but does not appear to have had adverse conservation impacts on local plant and small mammal diversity. (*The Victorian Naturalist* **123** (1), 2006, 29-37)

Introduction

Utility corridors such as powerlines, gas pipelines and water pipelines are widespread linear easements, often encompassing a surprisingly large total land area (Knight *et al.* 1995) and, in some cases, representing an important component of the regional landscape (Hill *et al.* 1995). These corridors are usually highly modified strips of vegetation passing through tracts of little-modified native vegetation, and dissecting and internally fragmenting natural areas of conservation significance (Goldingay and Whelan 1997).

The most noticeable visual impact of these corridors is the loss of tree cover and the associated simplification of vegetation structure. Regular slashing to reduce biomass levels for fire safety (Chief Electrical Inspector 1999), and applications of herbicides to prevent regrowth entering the wire security zone (Hill *et al.* 1995) are major ongoing management practices. In these powerline easements, vegetation regrowth of shrubby seedlings and coppice from stumps and lignotubers is usually managed by repeated slashing, spraying with herbicides, or grading (Goosem 1997). Native vegetation may be completely replaced by exotic grasses or woody shrubs (Goosem and Marsh 1997), or previously forested areas converted to shrublands (Kroodsma 1982). This type of vegetation management is not unique to utility easements, and often occurs along other linear corridors such as road verges and firebreaks.

There are concerns that easements have a significant impact on conservation values by loss of habitat and biodiversity, and invasion of exotic species. Changes to the vegetation composition and structure can result in changes in native fauna (Goldingay and Whelan 1997). For example, where rainforest vegetation was converted to grassland, the small mammal community also changed from rainforest species to grassland specialists (Goosem and Marsh 1997). Avifaunal studies (e.g. Rich *et al.* 1994; Baker *et al.* 1998) suggest that utility easements may contribute to the decline of forest-interior bird species, and may contain a species-poor subset of the birds found in the surrounding forest. The new habitat type created by tree removal and corridor management facilitates invasion by non-forest bird species and exotic bird species. The role of easements in facilitating the penetration of dogs, cats and foxes into natural areas also has been investigated (Andrews 1990; Catling and Burt 1995; Lindenmeyer *et al.* 1994; Goldingay and Whelan 1997), and access roads and maintenance activities associated with easements may be a source of weed invasion (Parendes and Jones

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2000; Lonsdale and Lane 1994; Tyser and Worely 1992). However, the relatively dense ground cover promoted by slashing, and selective use of herbicide in some types of easement vegetation, appear to provide suitable habitat for small native mammals (Macreadie *et al.* 1998; Goldingay and Whelan 1997; Pearce 2003), and vegetation management has the potential to maintain, or even increase, uncommon habitat suitable for rare species.

This study aimed to investigate the effects of management of a powerline on native plant species composition and vegetation structure, and to comment on the conservation implications of current powerline management.

Study Site

Bunyip State Park, Victoria, covers 16 622 ha in the foothills of the Great Dividing Range, and is bisected by a 500 kV electricity transmission line running from the southeast to the northwest of the Park. This easement was established in 1962 and has been repeatedly slashed on a four year cycle (Macreadie *et al.* 1998).

The Park contains a variety of vegetation types ranging from Closed Forest and Mountain Ash-dominated Tall Open Forest, through Open Forest to Heathy Woodland and Wet Heathland (Parks Victoria 1998). The Park contains about 400 vascular plant species (Parks Victoria 1998). The section of the Park in which the study was carried out has Botanical Significance as it contains Wet Heathland, a rare vegetation community in Victoria, and a population of rare Swamp Bush-pea *Pultenaea glabra* (syn. *P. weindorferi*) (Fraser *et al.* 2004). The Heathy Woodland is also of Regional Significance (Parks Victoria 1998).

The study site was a section of the powerline easement between Peppermint Track and the Bunyip River aqueduct, and encompassed approximately 1.2 km of the easement in the south east of the Park. The powerline cuts through Open Forest and a vehicle access track follows the easement, which is dissected by a series of low ridges and Wet Heathland drainage lines (Fig. 1). These drainage lines create relatively continuous cover from one side of the easement to the other. Due to the topographic position of the drainage lines they are rarely, if ever, slashed during routine maintenance operations. This section of powerline was investigated by Macreadie *et al.* (1998).

The modified vegetation under the powerline contains a wide diversity of species and is a mix of open, heathy areas and grassy areas with emergent shrubs. The forest vegetation on either side of the ease-

Fig. 1. Powerline easement through Open Forest, Bunyip State Park. The vehicle access track runs the length of the easement, and the undulating low ridge – drainage line nature of the topography is visible.

ment at this location is mainly Mealy Stringybark *Eucalyptus cephalocarpa*-dominated Open Forest, with a heathy understorey containing several species of *Banksia, Hakea* and *Acacia.* The ground layer is dominated by Wiry Spear-grass *Stipa muelleri* and several sedge species. Open Forest dominated by *Eucalyptus obliqua* and *Eucalyptus radiata* also occurs along this section of the easement. Trees are absent from the drainage lines that run through the easement, and these drainage lines are dominated by Wet Heathland containing Prickly Tea-tree *Leptospermum continentale* and *Gahnia radula* or Scented Paperbark *Melaleuca squarrosa* with a dense understorey of Pouched Coral Fern *Gleichenia dicarpa.*

Methods

Square quadrats (25 m^2) were placed at 100 m intervals along the easement starting at Peppermint Track and ending approximately 1.2 km away at the Bunyip River Aqueduct. Ten quadrats were placed in the forest on each side of the easement, and ten in the easement, with five on either side of the access track. To minimize any edge effects, all quadrats in the easement were placed at least 10 m from the track, and quadrats in the forest were at least 10 m from the easement edge. Species presence, and cover, estimated using a modified Domin Cover Scale (Kershaw and Looney 1985), were recorded. Quadrat data were investigated for floristic patterns using both classification and ordination techniques (PATN analysis package, Belbin 1991), and species in each quadrat were clustered using the Bray-Curtis association measure with fusion using Wards method (Belbin 1991). Plant cover is displayed (Table 1) on a relative scale from 1 to 5. Plant nomenclature follows Walsh and Entwisle (1994).

Understorey structure to a height of 120 cm was determined using a graduated structure pole, along 20 m transects at each vegetation quadrat. The number of vegetation contacts in each 10 cm interval on the pole is converted to a percentage, and allows comparison of vegetation cover at horizontal intervals vertically through the understorey (Fig. 2).

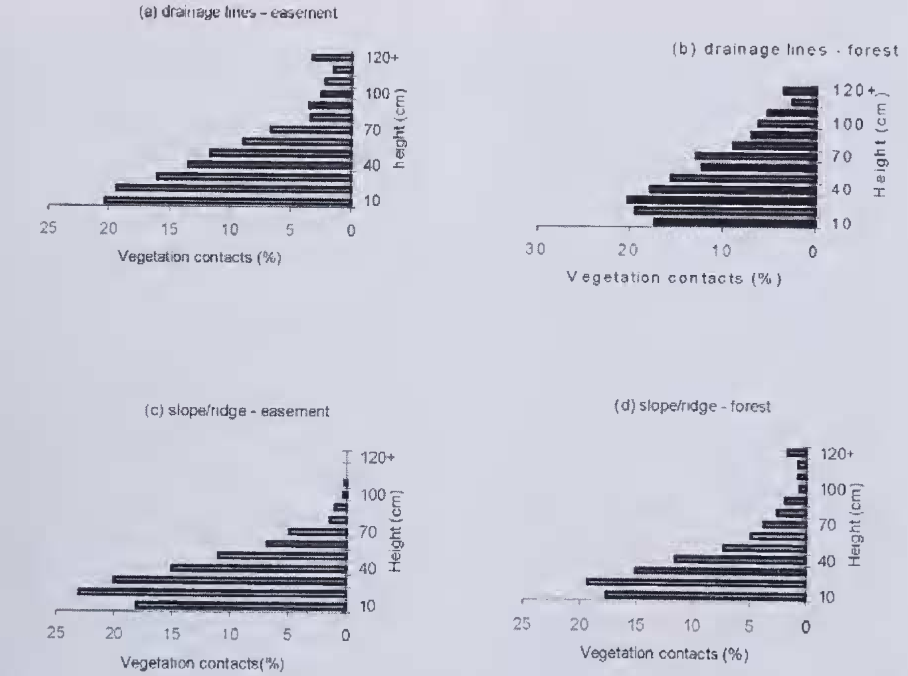

Fig. 2. Comparison of the understorey structure profiles for the powerline easement (a and c) and the surrounding Open Forest (b and d).

The structure data were pooled into four arbitrary strata (0–30 cm, 30–60 cm, 60–90 cm and 90–120 cm) for each of the four locations (easement slope/ridge, easement drainage lines, forest slope/ridge and forest drainage lines) and compared using two-way ANOVA. Data were examined for normality and homogeneity of variances, and the percentage data arcsine transformed for analysis. The differences between significant means were examined using Newman-Keuls multiple comparisons test.

Results

Vegetation structure

ANOVA results indicated a significant interaction between locations and structure ($F_{9,374} = 5.83$, $p < 0.001$). Newman-Keuls multiple comparisons tests showed that vegetation structure differed significantly ($p < 0.05$) in density in two strata for the slope/ridge locations in the easement compared with the slope/ridge locations in the surrounding forest (Fig. 2c and 2d). Vegetation density was not significantly different in the 0–30 cm or the 60–90 cm layers. In the easement, the vegetation layer between 30 and 60 cm was significantly more dense ($p < 0.05$) than in the forest, mostly due to a higher cover of grass, and vegetation was very sparse beyond 90 cm. In the forest, the vegetation structure was slightly more complex with a sparse layer of vegetation in the 90–120 cm stratum.

The structure of the vegetation in the drainage lines was similar regardless of whether the drainage lines were in the easement or in the surrounding forest (Fig. 2a, 2c and 2b, 2d). The only significant difference ($p < 0.05$) was slightly thicker vegetation between 60 and 90 cm in forest drainage lines compared with those in the easement.

The vegetation in the drainage lines is structurally different compared to the slope/ridge vegetation (e.g. Fig. 2a to 2d). Apart from the 0–30 cm layer, drainage line vegetation was generally thicker than the slope/ridge vegetation, especially in the taller strata (60–90 cm and 90–120 cm). This difference is due to the dense thickets of either *Leptospermum continentale* or *Melaleuca squarrosa*, with understories of *Gleichenia dicarpa*, *Ghania radula* or *Bauera rubioides* in the drainage lines. The slope/ridge vegetation comprised mainly low shrubs and *Stipa muelleri*.

Species composition and cover

Approximately 80 species were recorded, including 55 dicots, 14 monocots and 8 ferns. The only exotic species recorded in quadrats were *Cirsium vulgare* and *Hypochoeris radicata* and two unidentified herbs. *Erica lusitanica* and *Acacia longifolia* were infrequently observed growing in scattered locations adjacent to the access track.

The classification dendrogram (Fig. 3) indicated two primary vegetation types corresponding to drier vegetation from slope/ridge quadrats (Type 1) and vegetation from Wet Heath or drainage line quadrats (Type 2). Both these vegetation types could be subdivided into three variants, and each vegetation type was identified by high cover of a characteristic suite of species (Table 1).

Vegetation types

Vegetation Type 1: *Eucalyptus* Open Forest and derivatives

1a. *Eucalyptus* Open Forest: This *Eucalyptus cephalocarpa*-dominated Open Forest is widespread through the drier sections of Bunyip State Park, and may grade into Heathy Woodland. It is found on both sides of the easement on drier slope/ridge sites, and is the original forest type that occurred on the easement prior to modification.

1b. Originally *Eucalyptus* Open Forest of Type 1a. Although there is some regrowth of the canopy, the diversity of understorey shrubs is extremely low. This forest type is found in the easement along the forest edge, and results from slashing and partial regrowth following disturbance during the original powerline construction.

1c. *Stipa muelleri* grassland with emergent shrubs of *Acacia*, *Pultenaea*, *Epacris*, *Banksia*, *Dillwynia* and a dense cover of *Caustis flexuosa* and *Gahnia radula*. This is equivalent to the *Acacia–Banksia* type described by Macreadie *et al.* (1998), and is secondary grassland with stunted shrubs, formed by the removal of the *Eucalyptus* canopy of Type 1a and subsequent frequent slashing. This vegetation type is also characterized by a high incidence of bare ground. It was found only on slope/ridge sites within the easement.

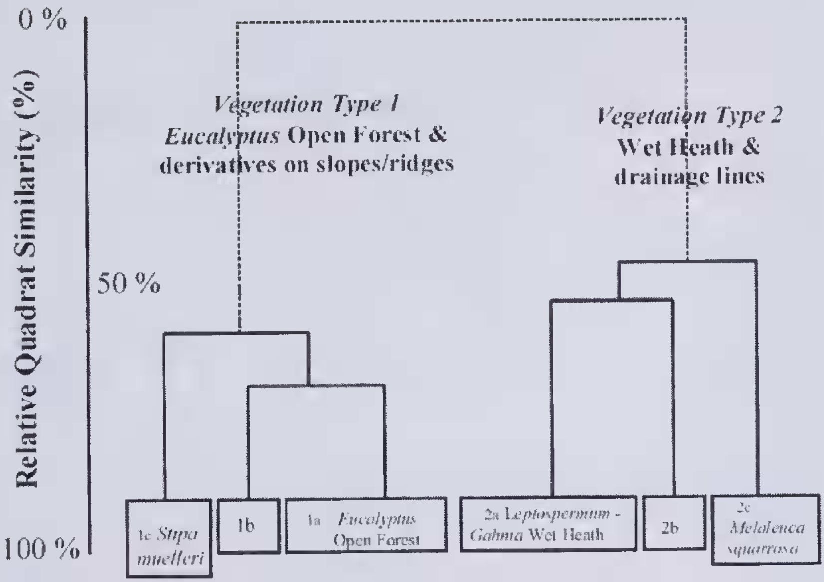

Fig. 3. Classification dendrogram showing the clustering of quadrats into two primary vegetation types – Eucalyptus Open Forest and derivative on slopes/ridges (Type 1) and Wet Heath and drainage lines (Type 2).

Vegetation Type 2: Wet Heath and drainage lines

2a. *Leptospermum continentale – Gahnia radula* Wet Heath: There is a high diversity of monocots such as *Tetraria capillaris* and *Baumea tetragona*. *Gleichenia dicarpa* is usually present, and *Stipa muelleri* is also abundant. It is found in wet sites and drainage lines in both the easement and forest. Most of the area covered by these drainage lines is too wet or inaccessible to slash.

2b. A variant of *Leptospermum continentale – Gahnia radula* Wet Heath: It is distinguished by a high cover of *Bauera rubioides* and the absence of most species found in Type 2a. There is a scatter of species not found in the other vegetation types, such as *Olearia ramulosa*. This vegetation type was the only one in which *Acaena novae-zelandiae* and *Cirsium vulgare* were found. It is found only in the less wet sections of drainage lines and wet sites in the easement where slashing is possible. It probably represents a more disturbed variant of Type 2a.

2c. *Melaleuca squarrosa* thickets: These thickets are characterized by an extremely dense *Gleichenia dicarpa* understorey. They are found in drainage lines in both the easement and forest. They are not slashed.

Discussion

Vegetation management along utility easements is aimed at modifying vegetation structure by the removal of tall shrubs and trees, and it might be expected that this management would result in habitat degradation and loss of diversity. However, the vegetation response to disturbance is dependent on the original vegetation type, and the individual management treatments used. Repeated slashing through dry sclerophyll forest in the Australian Capital Territory altered the vegetation structure by promoting eucalypt suckering and increasing the density of understorey vegetation compared with unslashed adjacent forest (Bell 1980). Vigorous suckering from stumps and roots is also reported after frequent slashing of powerline vegetation in North America (Luken *et al.* 1991), and suckering was controlled by herbicide applications. An easement through Queensland rainforest was converted to dense exotic grassland and patches of woody weeds (Goosem and Marsh 1997), and exotic grasslands and shrub-

Table 1. Floristic composition of vegetation types 1 and 2. Exotic species = *. Quadrats (n = 40) are displayed across the table, and the species present are listed vertically, with the values 1–5 representing relative cover. Plant nomenclature follows Walsh and Entwisle (1994).

Species	Type 1c *Stipa*	1b	1a *Eucalyptus*	2a Wet Heath	2b	2c *Melaleuca*	
Leptospermum continentale	11	113	1 111	1211111111	1213		widspread
Gahnia radula	523111	211	1 11111111111	2413 51311	5235	21 3	species
Eucalyptus radiata		24	132 2	5			
Eucalyptus cephalocarpa			22121 2 21214				
Eucalytus obliqua			32				
Lycopodium deuterodensum			11				
Banksia spinulosa			1 11 1	5			species
Xanthorrhoea minor			 111	1			restricted
Banksia marginata			111 12				to original
Daviesia leptophylla			11 1				Open Forest
Lomatia ilicifolia			11 1 1	1		1	
Hakea nodosa			1				
Exocarpos cupressiformis			1				
Hakea teretifolia			1	1			
Gompholobium huegelii			1				
Tetratheca ciliata			1				
Stipa muelleri	535555	555	5555555555555	12 555 15	53		
Bare ground	52222		1	31 1			widespread
Acacia oxycedrus	1	121	1111	113		1	species
Acacia genistifolia	11111	11	1111 1 1	12 1 1	1		from all
Pultenaea gunnii	1211 1	11	111 1 111	1 111	1313		sites
Dampiera stricta	11	1 1	1	1			except the
Moss	111	111	1		1		wettest
Amperea xiphoclada	1	111	1111		11	1	sites
Pteridium esculentum		1 1	2		1	1	
Caustis flexuosa	5531 1		1111 1 1 11	1 111			
Monotoca scoparia	111		1 1				widespread
Lepidosperma laterale	1 1111		112 1 1				species,
Epacris impressa	111111		1 1	11 1 111			but missing
Dillwynia glaberrima	111111		1 1 1	1 111			from dis-
Leptospermum myrsinoides	1 111		11	1 113			turbed sites (1b) and
Acacia aculeatissima	1		1	1		1	wettest
Hovea linearis	1		11 11				sites
Hakea ulicina	1		1 1 2 11	1 1			(2b and 2c)
Hakea decurrens	11 1		111 111 111			1	
Eucalyptus seedlings	1111			1	1	1	
Goodenia lanata	1						
Acacia myrtifolia	11 1 1						
Lomandra longifolia	1 1			1			species
Viola cleistogamoides	1 1						mostly
Stylidium graminifolium	1			1			found in
Acacia brownii	1						frequently
Persoonia juniperina	1						slashed
Kunzea ericoides	11						sites
Acrotriche serrulata	1						
Hydrocotyle laxiflora	1	1					
Gonocarpus micranthus	11	1		111 1	1		
**Hypochoeris radicata*	1	1		1			
Bauera rubioides	12 1	2	1	131 5 1	2555	22	species
Tetraria capillaris				55 511135	1	1	of wetter
Baumea tetragona				5 1 1		12	sites
Tetrarrhena juncea			2	51		1 1	

Table 1 cont'd.

Species	Type 1c *Stipa*	1b	1a *Eucalyptus*	2a Wet Heath	2b	2c *Melaleuca*	
Leptocarpus tenax				1 1 1			
Pultenaea glabra				13 11			
Epacris gunnii				1			species
Lobelia elata				11			confined
Selaginella uliginosa				11			to Wet
Lindsaea linearis		1		11			Heath (2a)
Senecio minimus				1			
Euphorbia spp.				1			
Melaleuca squarrosa				131		111	
Gleichenia dicarpa				111 5 1		5555	wet sites
Leptospermum lanigerum				1		1	with
Epacris obtusifolia				1		1	high
Restio tetraphyllus				1		1	cover of
Empodisma minus				1 1		11	*Gleichenia*
Patersonia fragilis				12 1		1	
Acaena novae-zelandiae					32		
**Cirsium vulgare*					11		uncommon
Cassytha glabella	1				11		species
Cyathea australis		1			11		of wetter
Olearia ramulosa					1		sites
Olearia lirata					11		
Ozothamnus ferrugineus						1	
Juncus pallidus						1	uncommon
Carex spp.						1	species
Dicksonia antarctica						1	of wettest
Blechnum cartilagineum						1	sites
Blechnum nudum						1	

lands developed in easements through hardwood and softwood forests in Tennessee (Kroodsma 1982). In all these instances, the vegetation composition was considerably altered from that of the adjacent forest vegetation. In these examples, vegetation structure was similar with no emergent shrubs or trees and a more dense layer of grasses or grasses with low shrubs in the disturbed areas.

The response of the Open Forest along the Bunyip easement is generally consistent with this pattern of structural change. The drier sections of the easement have been converted to *Stipa muelleri* grassland with patchy low shrubby species, while the wetter drainage lines show little change between forest and easement.

Some changes in floristics were identified. The original *Eucalyptus* Open Forest (Type 1a) understorey is composed of a diversity of shrubby species, *Stipa muelleri*, and other monocot species typical of Victorian dry heathy Woodlands and Open Forests. Overall, the total numbers of species recorded in the *Eucalyptus* Open Forest (Type 1a) (35 species) and the modified vegetation of Type 1b (38 species) were very similar. Species other than the canopy eucalypts and *S. muelleri* rarely had cover values greater than 20% projective foliage cover.

However, a comparison of the composition of the original *Eucalyptus* Open Forest (Type 1a) and the *Stipa muelleri* grassland (Type 1c) showed a difference in the species present. Seven shrub species recorded in the Open Forest were not recorded in the *S. muelleri* grassland on the easement. These were shrubs with a serotinous seed store such as *Banksia spinulosa*, *Banksia marginata*, *Lomatia ilicifolia*, *Hakea nodosa* and *Hakea teretifolia*, and the ant-dispersed shrubs *Daviesia leptophylla*, *Gompholobium huegelii* and *Tetratheca ciliata*. Seeds dispersed by ants are typically dispersed about one metre, limiting species' ability to recolonise once eliminated. Also absent from the modified easement vegetation (Types 1b and 1c) were *Xanthorrhoea minor* and *Exocarpos cupressiformis*.

Substantial areas of bare ground occurred in the *Stipa muelleri* grassland. Caling (1998) found that a number of species of low-growing sedge and herb had higher cover in soil-disturbed, linear firebreaks compared with the surrounding vegetation. These bare areas may provide colonisation sites for species with clonal or rhizomatous growth mechanisms such as some ferns, herbs and ground covers, and are represented in the *Stipa muelleri* grassland by *Gonocarpus micranthus, Hydrocotyle laxiflora, Goodenia lanata, Viola cleistogamoides, Lomandra longifolia, Stylidium graminifolium, Selaginella uliginosa* and *Lindsaea linearis*. These species also may be responding to increased light. Five shrubby species recorded only in the *Stipa muelleri* grassland were *Acacia myrtifolia, Acacia brownii, Persoonia juniperina* and *Acrotriche serrulata*, and the shrubby colonizer *Kunzea ericoides*. The exotic *Hypochoeris radicata also* was present.

The floristic composition and structure of *Leptospermum continentale - Gahnia radula* Wet Heath (Type 2a) and *Melaleuca squarrosa* thickets (Type 2c) in the drainage lines showed little difference between the easement and the adjacent forest. The drainage lines are generally too wet to slash, and have no emergent trees to threaten the wire security zone. Only the more accessible and less wet drainage line edges near the access track appear to be regularly slashed, and it is here that the variant of *Leptospermum continentale - Gahnia radula* Wet Heath (Type 2b) with a few weedy species is found. The rare Swamp Bush-pea *Pultenaea glabra* (syn. *P. weindorferi*) is limited to these Wet Heath sites.

Although intact forest vegetation appears to be relatively resistant to weed invasion (Brothers and Spingarn 1992), roads and linear easements continue to be identified as potential invasion corridors for exotic weeds (Parendes and Jones 2000; Lonsdale and Lane 1994; Tyser and Worely 1992). For example, in heathland in the UK, weed invasion potential increased with the degree of edge disturbance (Angold 1997). The heathy understorey vegetation in this section of the Bunyip powerline easement was remarkably weed-free. This may be the result of the use of slashing and selective herbicides as easement management techniques, and avoidance of soil disturbing techniques such as grading. Weeds were recorded only in the easement. *Hypochoeris radicata, Cirsium vulgare* and two unidentified weedy species were recorded from quadrats, although Spanish heath *Erica lusitanica* and *Acacia longifolia* were growing along access roads.

Vegetation structural changes resulting from frequent slashing may disadvantage some small mammal species such as *Antechinus agilis*, but because vegetation density is the main factor contributing to habitat suitability for many small mammals (Monamy and Fox 2000), the *Stipa muelleri* (Type 1c) grassland in the easement provides quality habitat for species such as *Rattus fuscipes* (Macreadie *et al.* 1998; Pearce 2003).

Goldingay and Whelan (1997) suggested that small mammals would use dense vegetation and habitat linkages within easements, and this is supported by this study. The structural similarity of the Wet Heath (Types 2a and 2c) in the easement and the Open Forest enables this vegetation to be used as a link across the easement. Several mammal species have been trapped more frequently in Wet Heath vegetation compared to the surrounding slopes/ridge vegetation. These included the rare Broad-toothed Rat *Mastocomys fuscus*, Dusky Antechinus *Antechinus swainsonii* (Macreadie *et al.*1998), and Swamp Rat *Rattus lutreolus* (Macreadie *et al.* 1998; Pearce 2003). The frequency of occurrence of *Mastocomys fuscus* was highest in vegetation with high cover of *Bauera rubioides* (Macreadie *et al.* 1998). It appears from this study that slashing disturbance to Wet Heath (Type 2a) results in increased cover of *Bauera rubioides* (Type 2b) and it is likely that the slashing regime in this section of the powerline easement has increased suitable habitat for *Mastocomys fuscus*.

This study suggests that repeated slashing of vegetation has altered species composition compared with unslashed forest vegetation, though some vegetation communities within the defined management zone, such as Wet Heath, largely escape treatment and consequently show few changes to structure or composition. At a regional level, plant species diversity is not reduced, and at the local level, overall species diversity has increased as suitable establishment sites were created for non-forest plant species. Higher vegetation density in the casement also appears to create small mammal habitat, and the Wet Heath in drainage lines provides movement corridors across the easement. There was no indication that the powerline easement facilitated weed invasion. Vegetation management by repeated slashing and targeted herbicide application under the Bunyip State Park powerline easement at this location has altered the vegetation, but does not appear to have had adverse conservation impacts on local plant and small mammal diversity.

Acknowledgements

Data collection was carried out under Permit Number 10002025. We thank Dr. Dianne Simmons, School of Ecology and Environment, Deakin University, for conducting the PATN analysis, and for comments on the manuscript.

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Received 10 February 2005; accepted 20 September 2005